

### **What is claimed is:**

**[Claim 1]** A process for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen, comprising:

solvent deasphalting at least a portion of the heavy oil or bitumen to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content; supplying a feed comprising the DAO fraction to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to deposit a portion of the metals from the DAO fraction onto the FCC catalyst; and recovering a hydrocarbon effluent having a reduced metal content from the FCC unit.

**[Claim 2]** The process of claim 1, further comprising converting the asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from the reservoir for feed to the solvent deasphalting.

**[Claim 3]** The process of claim 2, further comprising supplying the asphaltene fraction from the solvent deasphalting to the asphaltenes conversion.

**[Claim 4]** The process of claim 1, further comprising removing metallized FCC catalyst from the FCC unit.

**[Claim 5]** A process for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen, comprising:

converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir; solvent deasphalting at least a portion of the heavy oil or bitumen to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content; supplying the asphaltenes fraction from the solvent deasphalting to the asphaltenes conversion;

supplying a feed comprising the DAO fraction to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to deposit a portion of the metals from the DAO fraction onto the FCC catalyst;  
recovering a hydrocarbon effluent having a reduced metal content from the FCC unit; and  
removing metallized FCC catalyst from the FCC unit.

**[Claim 6]** The process of claim 5, further comprising producing heavy oil or bitumen by extraction from mined tar sands.

**[Claim 7]** The process of claim 5 further comprising producing heavy oil or bitumen by injecting a mobilizing fluid through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen and producing the mobilized heavy oil or bitumen from at least one production well completed in communication with the reservoir.

**[Claim 8]** The process of claim 7 wherein the mobilizing fluid comprises steam generated primarily by combustion of asphaltenes recovered from the asphaltenes fraction from the solvent deasphalting.

**[Claim 9]** The process of claim 6, wherein the asphaltenes conversion comprises gasification of a portion of the asphaltenes fraction to provide power, steam, fuel gas or combinations thereof for the mining and extraction.

**[Claim 10]** The process of claim 5 wherein the solvent deasphalting has a high lift.

**[Claim 11]** The process of claim 5 further comprising feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke.

**[Claim 12]** The process of claim 5 wherein lower boiling hydrocarbon fractions are introduced to the FCC unit with the DAO fraction.

**[Claim 13]** The process of claim 5 wherein the FCC unit is operated at a conversion from 30 to 65 percent by volume of the feed to the FCC unit.

**[Claim 14]** The process of claim 5 wherein operating conditions in the FCC unit are adjusted to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit.

**[Claim 15]** The process of claim 5 further comprising hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent.

**[Claim 16]** The process of claim 15 wherein the hydrotreating is effected at a moderate pressure of from 3.5 to 10 MPa.

**[Claim 17]** The process of claim 15 further comprising gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting to produce hydrogen for the hydrotreating.

**[Claim 18]** A process for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen, comprising:

- converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir;
- solvent deasphalting at least a portion of the heavy oil or bitumen containing metals to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content;

- supplying the asphaltene fraction from the solvent deasphalting to the asphaltenes conversion;

- generating steam by combustion of asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting;

- supplying a feed comprising the DAO fraction to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to recover a demetallized hydrocarbon effluent from the FCC unit at a conversion rate from 30 to 65 percent by volume of the feed to the FCC unit;

- hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent.

**[Claim 19]** The process of claim 18 wherein the heavy oil or bitumen production comprises injecting steam through one or more injection wells

completed in communication with the reservoir to mobilize the heavy oil or bitumen; and producing the mobilized heavy oil or bitumen from at least one production well completed in communication with the reservoir.

**[Claim 20]** The process of claim 18 wherein the heavy oil or bitumen production comprises extraction from mined tar sands.

**[Claim 21]** The process of claim 18 further comprising feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke.

**[Claim 22]** The process of claim 21 comprising feeding the coker liquids to the hydrotreating with the FCC hydrocarbon effluent.

**[Claim 23]** The process of claim 18 further comprising supplying decant oil from the FCC unit to combustion, gasification or a combination thereof.

**[Claim 24]** The process of claim 18 wherein operating conditions in the FCC unit are adjusted to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit.

**[Claim 25]** The process of claim 18 wherein the hydrotreating is effected at a moderate pressure of from 3.5 to 10.5 MPa.

**[Claim 26]** The process of claim 18 further comprising gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting to produce hydrogen for the hydrotreating.

**[Claim 27]** An apparatus for upgrading crude oil from a subterranean reservoir of heavy oil or bitumen, comprising:

means for converting asphaltenes to steam, power, fuel gas, or a combination thereof for use in producing heavy oil or bitumen from a reservoir;

means for solvent deasphalting at least a portion of the produced heavy oil or bitumen containing metals to form an asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content;

means for supplying the asphaltene fraction from the solvent deasphalting to the asphaltenes conversion;  
means for supplying a feed comprising the DAO fraction to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to deposit metals from the DAO fraction onto FCC catalyst;  
means for recovering a demetallized hydrocarbon effluent from the FCC unit; and  
means for removing metallized FCC catalyst from the FCC unit.

[Claim 28] The apparatus of claim 27, further comprising means for injecting a mobilizing fluid through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen; and means for producing the mobilized heavy oil or bitumen from at least one production well in completed in communication with the reservoir.

[Claim 29] The apparatus of claim 28, further comprising means for generating the mobilizing fluid comprising steam primarily by combustion of asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting means.

[Claim 30] The apparatus of claim 27, further comprising means for extracting heavy oil and bitumen from mined tar sands.

[Claim 31] The apparatus of claim 27 wherein the solvent deasphalting means comprises a high lift.

[Claim 32] The apparatus of claim 31 further comprising means for feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke.

[Claim 33] The apparatus of claim 27 further comprising means for operating the FCC unit at a conversion rate from 30 to 65 percent by volume of the feed to the FCC unit.

[Claim 34] The apparatus of claim 27 further comprising means for adjusting operating conditions in the FCC unit to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit.

**[Claim 35]** The apparatus of claim 27 further comprising means for hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent.

**[Claim 36]** The apparatus of claim 35 further comprising means for effecting the hydrotreating at a moderate pressure of from 3.5 to 10 MPa.

**[Claim 37]** The apparatus of claim 36 further comprising means for gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting to produce hydrogen for the hydrotreating.

**[Claim 38]** Apparatus for producing and upgrading crude oil from a subterranean reservoir of heavy oil or bitumen, comprising:

- means for injecting steam through one or more injection wells completed in communication with the reservoir to mobilize the heavy oil or bitumen;
- means for producing the mobilized heavy oil or bitumen from at least one production well completed in communication with the reservoir;
- means for solvent deasphalting at least a fraction of the produced heavy oil or bitumen containing high metals to form a resin-lean asphaltene fraction and a deasphalted oil (DAO) fraction essentially free of asphaltenes having a reduced metals content;
- means for generating steam for the injection means by combustion of asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting means;
- means for supplying a feed comprising the DAO fraction to a reaction zone of a fluid catalytic cracking (FCC) unit with FCC catalyst to recover a demetallized hydrocarbon effluent from the FCC unit at a conversion from 30 to 65 percent by volume of the feed to the FCC unit;
- means for hydrotreating the hydrocarbon effluent from the FCC unit to produce a low sulfur hydrocarbon effluent.

**[Claim 39]** The apparatus of claim 38 further comprising means for feeding a portion of the asphaltenes fraction to a delayed coker unit to produce coker liquids and coke.

**[Claim 40]** The apparatus of claim 39 further comprising means for feeding the coker liquids to the hydrotreating means with the FCC hydrocarbon effluent.

**[Claim 41]** The apparatus of claim 40 further comprising means for supplying decant oil from the FCC unit to combustion, gasification or a combination thereof.

**[Claim 42]** The apparatus of claim 38 further comprising means for adjusting operating conditions in the FCC unit to control proportions of naphtha, distillate and gas oil in the hydrocarbon effluent from the FCC unit.

**[Claim 43]** The apparatus of claim 38 further comprising means for effecting the hydrotreating at a moderate pressure of from 3.5 to 10 MPa.

**[Claim 44]** The apparatus of claim 38 further comprising means for gasifying asphaltenes recovered in the asphaltenes fraction from the solvent deasphalting means to produce hydrogen for the hydrotreating means.